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THE MAKING OF MAN.

BY CHARLES MORRIS.

FOR a period of many millions of years—how many not even conjecture can decide—the world of vertebrate life continued quadrupedal, the seeming deviations therefrom being rather apparent than real. Suddenly a true biped appeared. For a period of equal duration the mentality of animals developed with excessive slowness. Suddenly a highly intellectual animal appeared. The coming of man indicated, both physically and mentally, an extraordinary deviation from the established course of organic development. Both physically and mentally, evolution seems to have taken an enormous leap, instead of proceeding by its usual minute steps; and in the advent of the human species we have a remarkable problem, whose solution is as difficult as it is important.

It might be solved in a moment were we able to accept the arguments of those who hold that man is the outcome of a distinct act of creation, and is invested with powers and qualities, and prepared for a destiny, in which from the beginning he has stood apart from all other living beings. Yet these arguments no biologist of our day can accept. It has become clearly apparent that the points of distinction between man and the lower animals are simply of degree, not at all of kind, and that both physically and mentally man comes into close contact with the lower forms of life. They do not only touch, they are intimately interwoven. There is an intricate net-work of structural relations which binds man inextricably to the realm of lower life. This realm is not alone the basis on which he rests. It is the soil from which he has sprung, and into which he is so deeply rooted that not the hand of a god could tear him loose.

It is not our purpose here to give any of the arguments in favor of this conclusion. They may be found fully presented elsewhere. We design rather to endeavor to trace the line of ascent of man from the lower animal world, and to seek to discover to what combination of highly favorable circumstances his development is due.

Physically man does not deviate very greatly from the mammals next below him. His method of locomotion is essentially changed, but structurally he is very closely related to the higher apes. Yet so much are all living beings the creatures of circumstance, that it seems possible, and even probable, that the remarkable mental differentiation of man may be a necessary result of this comparatively slight physical differentiation. His erect attitude, with certain variations in his life-habits which directly arise from it, bring him into new relations with surrounding nature, and these new relations have certainly very much to do with the new conditions which have arisen within him. A single step may lead at times to a vast train of unexpected consequences, and such seems to have been the case with this new step in evolution made by man.

Man is the only true biped. He has but two points of support, while all other animals are supported at four or more specialized points, or else rest on the general surface of the body. In birds, for instance, which are usually considered bipeds, the wings are organs for aërial support, and have no other function. The nearest approach to man in this respect, among existing animals, may be found in the forms which progress by jumping, such as the kangaroo. Yet in these the structure and function of the fore limbs is distinctly locomotive. And such was probably the case with the dinosaurian reptiles of a past geological era, despite the fact that they seem to have been able to walk, to some extent, on their hind limbs alone.

It is certainly remarkable that, in the whole extended period of animal life, no single vertebrate form appeared, so far as we can discover, before the advent of man, in which the fore limbs were completely freed from duty as organs of support and became structurally unfit for this duty. A partial freedom in this respect would be of minor value, since the formation necessary to locomotive duty must be retained, and the development of any new functional power would be checked. Thus in this respect man is an anomaly in the kingdom of life. And to this anomalous feature is quite probably due in very considerable measure the peculiar character of his development.

It is very evident, indeed, that the full adoption of the erect attitude gave man an immense motor supremacy over the lower animals; for it completely released his fore limbs from duty as organs of support—for the first time in the known history of vertebrate life. They were set free to be employed in new methods and to develop new functional powers, to which the grasping function, which man inherits from the ape tribe, was an invaluable aid. It is to the possession of two limbs which are freed from any organic duty other than attack and defense, and which are adapted to grasp weapons and tools, that man owes his enormous advantage over the lower animals. It opens to him possibilities which do not exist beneath him. All the forces of nature are at his command, as soon as he can learn to control them. The first club or spear he grasped, the first missile he threw, inaugurated a new era in the history of life, and opened the way to man's complete mastery. And, so far as we can perceive, this important structural advantage preceded the development of his mental superiority, and gave the cue to it.

In the vertebrate class below man, there exists but a single animal form that possesses a limb which is free from duty as an organ of support. This is the elephant, whose nose and upper lip have developed into an enormous and highly flexible trunk, with delicate grasping powers. The possession of such an organ has undoubtedly had its share in the marked intellectual development of the elephant. Yet this organ is far inferior in its powers to the hand and arm of man, while the form, the size and the habits of this animal stand in the way of its gaining the full results which might arise from the possession of such an organ in connection with a better adapted bodily structure.

As to the evolutionary processes through which man gained the peculiar features of his structure, we have interesting evidence in the existing forms of life. In one type of life, and one alone, can we perceive indications of a gradual variation from the quadrupedal towards the bipedal structure. This is the ape type, or rather that of the lemurs and apes in conjunction. In all other mammalian types the aspect of the body is distinctively horizontal. Life in trees does not necessarily produce a deviation from this horizontal aspect, since it is retained by all arboreal mammals except those just mentioned. Yet it offers an opportunity for such a deviation, and this opportunity has been improved by the lemurs and apes. Their hands have developed a grasping power which is possessed by no other arboreal animal, and which opens to them new motor possibilities. They may assume a semi-erect or a fully erect attitude, by grasping upper branches with the hands. And this ability, in the higher apes, has led to the development of a mode of progression on the ground which is more or less intermediate between the quadrupedal and the bipedal modes.

This fact is of great interest, as it seems to lead us directly towards the development of the bipedal habit, as attained in man. Though such a habit may be partly attained by tree-living animals, a residence on the ground is essential to its full development. And it is significant, in this connection, that no existing apes have fully given up the arboreal habit.

Of the anthropoid apes, the orang and the chimpanzee dwell habitually in the trees. On the ground they are out of their true element. The same is the case with all the species of the gibbons. All these creatures move with some difficulty on the ground, but freely and easily in the trees. The gorilla, on the contrary, seems to dwell more habitually on the surface. Its great weight tends to render an arboreal life unsuitable, and its hand is not so well adapted to climbing as that of the chimpanzee. Yet it has only in part given up its arboreal residence. It ascends trees for food and, to some extent, to sleep, though there is some reason to believe that the adult males sleep occasionally, and perhaps habitually, on the ground. It seems to be in a transition state between the arboreal and the surface life-habit.

Of the lower apes, the baboons make the ground their usual place of residence. They have not lost their climbing power, however, but can ascend trees with ease and rapidity. Most of the other apes dwell wholly, or nearly so, in the trees.

This fact of the partial or complete arboreal habit of all existing apes is of importance in this connection. It prevents any of them from attaining the peculiar structural development of man. The mode of progression best adapted to a life in trees is opposed to the erect attitude of man, and this attitude could not be fully gained except by a species which dwelt wholly on the ground. And life in trees absolutely requires the use of the arms as locomotive organs, and prohibits that freeing of them from this duty which exists in man. When man ascends trees he is obliged to return to the habit of his ancestors and use his arms as organs of progression. It seems evident, therefore, that if man descended from the apes his ancestral species must have been a form which had fully given up its life in trees, and had become almost as awkward in climbing as man now is, ere it fairly began to change from ape into man.

The adoption of a surface residence by any ape would necessitate certain changes in structure. Tree-dwelling apes, when they descend to the ground, present us frequently with an awkward compromise between the horizontal and the vertical modes of motion. Neither of these modes is natural to them, and to become properly adapted to either some change of structure is necessary. Many of them progress in the true quadrupedal manner, and in one ground-living tribe, the baboons, the structure of the body has suffered an accordant change. They have become true quadrupeds.

In other cases there is an inclination towards an erect mode of motion. Even among the lemurs this is occasionally displayed. Some species of these progress on the ground by jumps, the body being semi-erect and the arms held above the head. The anthropoid apes all have a curious mode of progression on the ground, intermediate between the erect and the horizontal methods. The orang, the chimpanzee and the gorilla alike use their four limbs in progression, but in a manner very unlike that of ordinary quadrupeds. They swing the body in a curious fashion between the arms. It is a sort of half-jumping, half-walking motion. Resting the body on the hands, the animal swings itself between the arms, and moves forward by a quick succession of such lifts and swings. In this movement the orang and the chimpanzee bring their closed knuckles to the ground, but the gorilla is said to keep the hand open and apply the palm to the ground. The outer edge rather than the sole of the foot touches the ground. The whole movement is as awkward as is that of man when he attempts to climb trees, and seems to indicate that there can be no satisfactory compromise between the two life-habits. A surface-dwelling animal must tend to become either a quadruped or a biped.

The actual result in all these cases seems to depend largely on the comparative length of the arms and legs. All the three species named have shorter legs and longer arms than man, and can thus readily lift their bodies upon their arms while in a semi-erect attitude. Yet they all are obliged to incline the body forward in movement. This is less the case with the gibbons, the extreme length of whose arms enables them to reach the ground with the hands without bending the body. Thus the gibbons can walk on the four limbs with the body erect.

Certain species of the gibbon can readily walk erect on their legs alone by balancing themselves with their arms. They often do so, and can even move tolerably fast, the body rocking from side to side. But if urged to speed they drop their long arms to the ground and progress in the swinging fashion. Of the other forms there is no satisfactory evidence that the orang ever walks erect, though it may be able to assume the erect attitude when attacked. Mr. Savage says that the chimpanzees are sometimes seen walking erect, the body bent forward, with the hands clasped over the occiput to balance. But on the appearance of danger they immediately take to all fours to fly.

The gorilla seems more inclined to walk erect, or rather in an inclined position, the body bending forward, with the head hung down. And it stoops less, when on all fours, than the chimpanzee, since its arms are longer. When walking it balances its huge body by flexing its arms upwards. Its gait is a rolling one, from side to side. When attacked it seems to always assume the erect posture. In structural formation it is better fitted to the erect attitude than is the gibbon.

The subject here considered is of considerable importance in its relation to the evolution of man. We observe various phases of tendency towards the biped habit, and can readily perceive that the walking gibbons or the gorilla might in time become true bipeds if they should completely give up their arboreal residence. The length of the arms is an important element in this problem. In all the species mentioned the length of the arms differs, but in all it is longer, as compared with the body and legs, than in man. The species from which man descended, with its longer legs and shorter arms than in the existing anthropoid apes, could not, without the greatest difficulty, have adopted their swinging mode of motion. Nor could it advantageously have assumed the quadrupedal habit, as in the baboon, whose four limbs are nearly equal in length. It was forced towards the bipedal habit by sheer necessity. On taking the ground surface for its place of residence, it was probably obliged to walk erect as the only movement to which its structure was well adapted. Neither the quadrupedal nor the semi-quadrupedal movement would have been suited to the proportions of its limbs, and its ancestral movement in trees may have been more vertical than is common with apes. Its bipedal development may have begun while it was still arboreal.

This erect posture once fully assumed and the arms thus completely freed from duty as organs of support, the animal, yet an ape, would have had an advantage of the greatest value over its fellow apes, and over all other members of the animal kingdom. Nearly all quadrupeds use their limbs to some extent in attack and defense. Yet the necessity of resting on these limbs interferes to a certain extent with this duty. In the animal in question the duty of locomotion being confined to the hind limbs, the fore ones were completely set free to be used as weapons. And to this power was added that very important one of their peculiar adaptation to grasping, which enabled the creature to add greatly to its natural strength by the use of missile and other weapons.

This advantage has not been confined to man and his progenitors. The power of the grasping function in this direction is of service to many of the apes. The story of the cocoanut-flinging monkeys does not need to be repeated. And it is equally well known that the orang, when attacked, will break off fragments of branches and shower them to the ground in a rage. But in all such cases there is nothing to indicate any precision of aim. The throwing seems to be done at random. It is probable that the arm has to be educated to the proper use of missiles, and that to gain this function it must be freed from other duties.

There is no positive evidence that any apes use weapons except in this manner. The story is told that the chimpanzee will wrest the spear from the hunter and use it against him. But this story needs to be verified. Also the common picture of the orang walking erect and supporting itself with a staff is entirely imaginative. Nothing of the kind was ever seen in nature. The teeth seem the main dependence of these creatures for purposes of defense. They will break off limbs and twigs and make themselves beds with great rapidity, but this seems the utmost limit of their constructive powers.

As for the animal from which man descended, it must have quickly gone further than this in the use of artificial weapons and in the arts of construction. Possibly its first assumption of the erect attitude may have been aided by the use of a staff, and if so, this would naturally be employed as a club or a spear on occasion. Through uses of this kind the arms would gradually become educated to their new duties, and gain facility in important movements which were impossible while they were forced to retain their locomotive adaptation.

This line of argument need not be carried further. It is evident that we have here the beginning of a new course of development whose end is yet in the future. The freedom of the arms and hands from the duty of support, their grasping power, and the use of artificial weapons and tools, were unquestionably main elements in the evolution of man. For under such circumstances the employment of artificial instruments would naturally be progressive. There would be no limitation to this progress from the necessity of using the arms for other duties, and such structural limitation as may have originally existed must gradually have disappeared, through increasing performance of and growing adaptation of the arms and hands to these new duties. The use of clubs in attack and defense, and of stone missiles for the same purposes, might readily have been adopted by an ape so constituted, and modern archæologists do not hesitate to trace all subsequent development in the arts to just such a simple beginning. Rudely chipped stones are found as early weapons of primitive man. Naturally shaped stone weapons undoubtedly preceded them.

Whether one or more species attained this bipedal development is a question not easily settled. It is almost certain that there was one only. Yet, if so, variations in the structure of this original biped must have taken place at an early date, possibly ere it became a full biped and began to strongly resist the molding influences of nature, if we may judge from the essential structural differences between the principal races of mankind.

Yet highly favorable as was the structural development of the original man, it needs no extended consideration of the subject to perceive that in this we have but one of the factors to which he owes his supremacy. The freeing of the arms to the performance of new duties was an essential agent in any rapid mental development. Yet it was not the only agent. The mental development of man began in the mental development of the apes. It is but the completion of a process which extends much further back than the beginning of the human era, and through which, in one type of life, the mammalian intellect attained an exceptional unfoldment. Human mental progress began at the high level attained by the anthropoid apes. To the causes of the unfoldment of the ape intellect some attention is therefore due.

There is nothing in an arboreal residence in itself to specially promote mentality. The squirrels and other arboreal quadrupeds are not of a high intellectual grade. Undoubtedly the activity, the variety of motions, and the grasping power of the monkeys must have aided in their mental unfoldment, yet we find that the lemurs, with the same general organization and life-habits, are intellectually dull. For the inciting element to the development of the ape intellect, therefore, we must look further.

Among the lower life forms the Carnivora are more intellectual as individuals than the Herbivora. Yet as groups the latter occasionally display intellectual conditions far higher than anything attained by the solitary Carnivora. These instances of intelligence are only found among the social species, and are displayed most remarkably in the communal classes, the ants, bees and beavers.[1] Yet even in these the purely plant-feeding bees fail to display the great variety of intelligent acts of the partly carnivorous and actively belligerent ants. It would appear, therefore, that while the activity and cunning arising from carnivorous habits aid in the development of individual intelligence, it is equally aided by social habits, and that a combination of these two requisites presents the most favorable condition for high progress in intelligence.

In fact, if we consider fully the ants, we find that these minute creatures, with none of the advantages in structure over their fellows possessed by man, have advanced politically and industrially to a level which was not reached by man until after he had dwelt for ages upon the earth. And, so far as all indications point, this exceptional development is due to social or communal influences alone. It appears, therefore, that social combination is a highly essential agent in intellectual development, quite as important as, perhaps more important than, any special advantages in structure and individual habits.

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[1] See Communal Societies, *Popular Science Monthly*, Jan., 1886.

The solitary life of cats, spiders, &c., while aiding to develop mentality in individuals, prevents the transmission of useful ideas. Only instincts are transmitted. Ideas die with their originators. On the other hand, the communal habits of ants and bees, while highly adapted to the preservation of useful ideas, tend to hinder individual excursions of mind and the rapid growth of ideas. An ant community is a society of strict specialists. The best condition for intellectual progress would seem to be an intermediate one, in which complete individual activity exists, yet in which social links are closely drawn, so that ideas may be transmitted by education and observation, as well as instincts by heredity. And to the fullest utility of this condition some degree of carnivorous habits would seem essential. It needs no intellectuality to gather fruit from the trees. It needs often the highest exercise of cunning to capture animal prey, while it produces a variety of perilous and exciting situations to which the strict vegetarian is not subjected.

Among modern apes socialism exists in various degrees. The lemurs display but little socialism. Some species of monkeys display it in a high degree, and it is a general characteristic of the family. Mutual aid in danger is common, education is not wanting, combination in enterprises is frequently observed, and probably through these and the like influences, observation and imitation have been developed to a degree not seen elsewhere among the Mammalia. Yet so advantageous is social combination in promoting intelligence, that the high degree of cunning displayed by baboons, in posting sentries while robbing fruit plantations, is but a fuller development of a similar habit possessed by several species of otherwise dull social animals.

Among the existing anthropoid apes, however, the social habit is greatly lacking. The orang, the chimpanzee and the gorilla are more or less solitary in their habits. The orang is particularly so, and is never seen in groups of more than two or three. The chimpanzee and the gorilla are somewhat more social, yet not markedly so. The groups of the gorillas appear to be polygamous bands, since they never possess more than one adult male, the rest of the band being composed of females and young. There is more evidence in favor of the chimpanzees combining in larger groups, yet this does not appear to be their usual habit. Reade remarks that both these species, without being gregarious, sometimes seem to assemble in large numbers. Unfortunately very little satisfactory information is possessed as to their habits in a state of nature.

These large apes are also strictly vegetarian. They lack the incitement to intellectual development arising from carnivorous habits. On the whole, then, their marked powers of intellect are somewhat surprising. It is probable, if we may judge from the habits of the lower monkeys, that the anthropoids descended from social species, and have in part lost their social habits. This is also indicated by the fact that the young of these anthropoid apes seem more inclined to socialism than do the adults. It is also shown in the higher socialism of the gibbons, the existing representatives of the primitive anthropoids.

If we seek, then, for the ancestors of man in the family of apes, we must look for a species possessed of several essential requisites, all of which can be found in no existing apes. These requisites, as considered in the preceding pages, may be briefly summarized.

The ancestor of man must have been of sufficient size and weight both to render continued life in the trees inconvenient and to give the necessary strength to combat with the perils of a surface life. His strength, indeed, must have been sufficient, combined with his cunning, to make him a match for the larger animals. He must have been aggressive as well as defensive, and if not originally carnivorous must have become so in a degree. Strictly herbivorous habits would have tended to check mental development.

Second, and yet more important, was the assumption of an erect attitude, and of a true biped structure, with the complete freeing of the fore limbs from duty in locomotion. There naturally followed upon this an increase of that use of missiles already possessed by the apes, with an advancing skill in the use of artificial weapons as the arms became adapted to this new function. With this came that dominance over the lower animal world which has been so essential a feature in the progress of man. And with it began his still increasing control of the energies of nature.

To these physical conditions must be added the social one. The ancestors of man could not have been solitary in their habits, but must have been strongly social. It is possible that the solitary condition of the existing great apes is a result of their strictly vegetarian habits. An anthropoid with carnivorous tendencies and original social habits would tend to increase rather than to lose these habits, through the great benefit derived from mutual aid in conflicts with the larger animals. That man, at an early period in the stone age, waged war with the largest animals, we have satisfactory evidence in the results of archæological discovery.

The original human society must have been one of mutual aid, combination in enterprises, some degree of language, or of the use of sounds conveying warning and information, protection and education of the young, and habits of observation and imitation. All these exist in some tribes of monkeys. As to vocal powers, the gibbons possess them in a high degree, though there is no evidence to show that any existing apes have specialized sounds to convey special information. It is to a group of the higher apes which possessed these characteristics in an unusual degree that we must look for the ancestors of man. If we be asked for traces of such a group we can but point to man. The ancestral line has vanished in that of its descendants. The existing anthropoid apes are but side issues in the problem.

The development of the social condition and of the educational process must have had a vigorous influence in the enlargement of the brain. In man the dividing line between the physical and the mental powers, as organizing agents, was finally passed. A tribe had arisen, for the first time in the long history of animal life, that trusted more to its mind than to its muscles, and which had begun to substitute artificial for natural tools and weapons. With the attainment of this condition there was taken the first decided step in that long line of mental progress which has produced the brain of man. In all preceding ages evolution had been mainly physical, and exerted its chief influence upon the limbs and muscles. Now, for the first time, mental evolution gained the supremacy, and development centered itself in the brain, the organ of the mind, while the body, in great measure, ceased to change.

Under these circumstances there is nothing very surprising in the fact that the human brain has attained an exceptional development, or that its growth was strongly marked at a very early date. How far it has increased in size over that of its non-human ancestor, we cannot judge from comparison with the brains of any existing apes, since these may be of a much lower grade of development. They are probably not fair standards of comparison. And if the body stood almost unchanged for ages, and all the influences of nature centered themselves upon the brain, a considerable increase in size and some variation in structure were inevitable consequences, and it is not easy to perceive, under the circumstances, that there is anything extraordinary in the special growth of the human brain.

In the making of man, then, we perceive the critical step that took the animal world over the dividing line between physical and mental evolution; and in human development we are concerned, not with the maturity of an old, but with the infancy of a new evolutionary process, which is full of far-reaching and extraordinary possibilities, of which the intellectual progress yet attained by man may be but the beginning. There may be needed as many millions of years for the full development of the mind as have been consumed in the evolution of the body, and the organ of the mind may yet attain an importance in the scheme of the physical organism of which we have no conception.

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REVIEW OF THE PROGRESS OF NORTH AMERICAN INVERTEBRATE PALÆONTOLOGY FOR 1885.

BY J. B. MARCOU.

THE year which has just passed shows a marked increase in the number of palæontologic articles. The tendency to publish new species without any illustrations is also diminishing, and those interested in the science can look with great satisfaction on the augmented activity of North American invertebrate palæontology.

T. H. Aldrich gives "Notes on the Tertiary of Alabama and Mississippi, with descriptions of new species," and "Notes on Tertiary fossils, rare, or little known," in the Jour. Cincinnati Soc. Nat. Hist., Vol. VIII, pp. 145 and 153. "Observations upon the Tertiary of Alabama" appeared in the *Amer. Jour. Sci.*, 3d ser., Vol. XXX, p. 300.

H. M. Ami has a "List of fossils from Ottawa and vicinity,"